Study of the Effect of Surat-Shabd Yoga Meditation on Psycho-Physiological States of Consciousness

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by

Rosy Parmar

Under the supervision of

Supervisor
Dr. Dayal Pyari Srivastava
Dept. of Physics and Computer Science

Co-Supervisor
Prof. Sukhdev Roy
Dept. Physics and Computer Science

Forwarded by

Prof. Vibha Rani Satsangi
Dean, Faculty of Science
Head, Dept. of Physics and Computer Science

PHYSICS AND COMPUTER SCIENCE, FACULTY OF SCIENCE
DAYALBAGH EDUCATIONAL INSTITUTE
(Deemed to be University)
Dayalbagh, Agra- 282005

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1. Introduction

Yoga is an ancient Indian philosophical tradition that has a spiritual essence which means, "*union with supreme consciousness*" (Misra, 1960, Satsangi, 2010b). Meditation is an integral part of yoga, which is more than just physical exercises. Meditation has been practiced since time immemorial in numerous religious traditions and beliefs, primarily as a means to attain enlightenment and self-realization (Radhakrishnan, 2009). The Yoga Sūtras of Patañjali, a collection of 196 Indian sutras (aphorisms) on the theory and practice of yoga, areconsidered to be one of the foundational texts of classical Yoga philosophy (Iyenger, 1966).Yoga-meditation is a very well-established experiential science that involves a systematic procedure to realize a wide spectrum of consciousness, which spans the physical, mental and spiritual states (Vivekananda, 2009). The different states of consciousness are repeatable, reproducible and verifiable by an adept. Progressive revelations of higher states of consciousness and the meditation techniques to attain them have been made, by sages and saints over the last millennium. It is widely accepted fact in most of the philosophical traditions that man is a perfect microcosm of the macrocosm. The human form is considered to be the most advanced life form that possesses the capability to attain ultimate reality or supreme consciousness (Kumar, 2006, Easwaran, 1997).

The entire spectrum of consciousness can be divided into three grand divisions, namely, physical, mental and spiritual. Over the years, a wide variety of meditation practices have evolved and have been developed, primarily by sages and saints that focus on attaining different states of consciousness, pertaining to these three categories (Das, 2016).

It is difficult to define meditation as it covers a wide range of dissimilar practices in different traditions and many that have the same form but are known by different names. Broadly, meditation techniques may be categorized into two, namely, focused or concentrative meditation and open monitoring or mindfulness meditation (Lutz et al., 2018b).

Focused or concentrative meditation involves voluntary focusing of attention on a chosen object, breathing, image, koan, word or mantra, at a particular nerve centre, such as in transcendental and

ultra-transcendental (Surat-Shabda-yoga) meditation whereas, open monitoring meditation involves non-reactive and non-judgmental monitoring of the content of experience, which include mindfulness, shikantaza and other awareness states. There are hybrid practices that use both methods and include vipassana (which uses anapanasati as a preparation) and samatha (calm-abiding) (Venkatesananda, 2010).

The primary objective of yoga-meditation is to control the mind and senses, attain a thoughtless state, such that higher states of consciousness are experienced that get more and more refined, till one attains supreme consciousness (Satsangi, 2010b). According to tradition, there is a well-defined protocol that requires a disciplined practice under the tutelage of an adept.

In contrast, in the west, yoga has primarily developed into a health and fitness attaining technique that is posture-based and leads to relief from stress and hence relaxation (Yatendra, 2019).The impact of postural yoga on physical and mental health has evoked tremendous research interest worldwide, with growing evidence that regular yoga practice yields a variety of health benefits. In 2016, UNESCO listed yoga as an intangible cultural heritage.

Modern science is still unable to decipher the mind-body relationship and hence, the relationship between health and well-being. Consciousness is considered to be the final frontier for science, as an understanding of this very fundamental aspect would help scientifically resolve deeper questions of human existence (Radhakrishnan, 1997, Rao 2005). The advent of advanced neuroimaging techniques and computational power has opened up tremendous opportunities to understand the human brain and different states of consciousness. This has led to the creation of trans-disciplinary areas of research in consciousness studies that include neurophenomenology, neurotheology, neuro-aesthetics, artificial intelligence and quantum cognition.

2. Surat-Shabd Yoga (Ultra-Transcendental) Meditation

Nada yoga is an ancient Indian practice of meditation on sound currents that is expounded in various Indian scriptures such as the Nadabindu Upanishad and Rig Veda. The practice of nāda yoga has been

widely affiliated within many yoga traditions including bhakti or devotional yoga, kundalini and tantric yoga, laya yoga, and raja yoga (Iyenger, 1996).

Surat is the soul or consciousnessof an individual, while Shabda is the 'divine sound current', the 'essence of supreme consciousness'. Etymologically, Surat-Shabd Yoga means the 'Union of the individualconsciousness with supreme consciousness' (Misra 1960, Satsangi, 2010a). Surat-Shabda Yoga is a type of spiritual yoga practice in the Sant Mat tradition that can be traced to the teachings of Sant Kabir. It involves two stages, (i) concentration on the fundamental sound current, i.e., a mantra along with contemplation of a form at a specific nerve centre, and (ii) harmonizing with spiritual sound currents, which leads to the attainment of higher states of consciousness. The advanced forms of Surat-Shabda-Yoga meditation focus on higher sound currents or mantras that help in transcending consciousness beyond that of the universal mind (transcendental states) to the pure spiritual or absolute domain of consciousness (ultra-transcendental states) (Satsangi, 2010a, b).

3. Scientific Studies of Meditation

Recent years have witnessed an increase in the scientific study on the processes and effects of Consciousness and Meditation. Since the 1970s, clinical psychology and psychiatry have recognized meditation techniques for numerous psychological conditions. Psycho-physiology has become a branch of neuroscience that seeks to understand how a person's mental state and physiological responses interact to affect one another. It is a mind-body relative study. Modern interest in this area employs methods to determine how some incidents affect human responses. Presently non-invasive approaches and modern practices have emerged to study psycho-physiological connections between the mind and body. Today psycho-physiologists can use a variety of these non-invasive methods to better understand human behavior and cognition with the goal of improving health.

Mindfulness practice has been employed in psychology to alleviate mental and physical conditions aiming to heal the mind, which led to its research in behavioral science. The traditional philosophy on morals relies on rationality, principled thinking and willpower of human being, but recent evidences strongly suggest that moral judgment and pro-social behavior are influenced by emotions and

intuition. Training emotions cultivates morality and hones compassion (Bankard, 2015). In Buddhism meditational training is given to improve moral cognition which has shown positive results (Sevinc and Lazar, 2018). Amongst all the psychological therapies, behavioral therapy is the fastest growing area. Meditation has become a popular and effective tool in cognitive behavioral therapy to cure predominant obsession and rational emotive therapy to generate positive emotions (Kumar et al., 2016). A study on effects of mindfulness on drug use and heavy drinking provides clinical report on relative efficacy of mindfulness-based relapse prevention and standard relapse prevention treatment for substance use disorder (Brewer, 2019). Rather than causing overwhelming desires, psychological distress and unhealthy or dysfunctional behavior, through meditation, thoughts can be made empty in a manner that they only appear as mental states that arise and dissipate (Papies et al., 2015).

Research on mindfulness meditation has proved very effective in healing some serious disorders. Preventative interventions on major depressive disorder carried on young adults released their stress and helped to bring out patients from the state of depression (Breedvelt et al., 2018). Estimation of the stress level and heart rate variability resulted in reduced heart rate with reduced stress (Sheareretal., 2016). It has also given positive results for people suffering with progressive multiple sclerosis (Bogosian et al., 2016). Diabetes patients when made to undergo mindfulness self-compassion intervention reported reduction in the levels of depression and distress (Friis et al., 2016). In another experimental study researchers combined meditation with aerobics for training purposes which resulted in reduced depression and rumination and enhanced synchronized brain activity (Alderman et al., 2016).

Motivated from the positive results of mindfulness meditation many programs for healing through meditation have been started all over the world which have become widely famous (Rao et al., 2015). Programs on mindfulness-based compassionate living training in a heterogeneous sample of psychiatric outpatients have given positive results (Bartels-Velthuis et al., 2016). Other programs like mindfulness-based-stress-reduction (MBSR) and mindfulness-based cognitive therapy (MBCT), which uses a combination of meditation with cognitive behavioral therapy (CBT) are quite popular. MBCT reduces symptoms of depression in people with a traumatic brain injury (Bédard et al., 2014).

The validation of an active control intervention for MBSR has been provided based on behavioral meditation (MacCoon et al., 2012). MBCT approach has been clinically approved by the National Institute for Clinical Excellence in the UK and is considered as 'treatment of choice' for depression. The study of mindfulness meditation and CBT provide a broader evidence base for psychological intervention on patients with insomnia. A survey on broader context of contemplative practice surrounding mindfulness meditation proves its relevance to cognitive psychology (Ainsworth et al., 2013). Doctors have also been able to reduce anxiety and mood symptoms in the patients by mindfulness-based therapy (Hofmannet al., 2010). Mindfulness meditation therapy has been proved to be very effective in treatment of post traumatic stress disorder (King et al., 2016a,b). Effort has been made to define mindfulness meditation in psychology and cognitive neuroscience while generating methods to train non-meditation practitioners to report their meditational experience (Abdoun et al., 2019). Mindfulness meditation has progressed from being a fringe topic of scientific investigation to being a justified replacement for psychotherapy in certain cases. It has become a tool to generate general well-being which further increases cognitive levels and also produces reflection on the brain. MM can be engaged as a self-guided health-related lifestyle behavior, similar to physical exercise, for cumulative benefit and preventive effects (Wielgosz et al., 2019). Mindfulness training is also considered to improve the moral cognition to become the back bone of a system prospective to better worldliness (Sevinc and Lazar, 2018).Mindfulness meditation is modulated into positive emotion based meditation for improving emotional regulation in the practitioners (Valim et al., 2019).

Metta meditation cultivates an attitude of love and kindness toward everything this includes enemies and sources of stress and builds consequential personal resources. Evidence provided by research on 139 working adults, half of whom were randomly-assigned to begin a practice of loving-kindness meditation show that this meditation practice increased over time in daily experiences of positive emotions, which, in turn produced increase in a wide range of personal resources (e.g., increased mindfulness, purpose in life, social support, decreased illness symptoms) and increase in life satisfaction and reduction in depressive symptoms (Fredrickson et al., 2008). Combined with empirically supported treatments, such as cognitive behavioral therapy, love-kindness and compassion

meditation may provide potentially useful strategies for targeting a variety of different psychological problems that involve interpersonal processes, such as social anxiety, marital conflict, anger, and coping with the strains of long-term care-giving (Hofmann et al., 2011). Multilevel analyses of daily data on the patients with persistent lower back aches show that more loving-kindness practice on a given day is related to lower pain that day and lower anger the next day. Preliminary results suggest that the loving-kindness program can be beneficial in reducing pain, anger, and psychological distress in patients (Carson et al., 2005). Non-practitioners trained in a 12 week randomized program showed signs of reduced ageing factors (Leet al., 2019).

Transcendental meditation (TM) considered a form of deep meditationhas positive and significant documentable neurochemical, neurophysiological, and cognitive-behavioral effects. Among the main effects are the reduction of anxiety and stress (due to the reduction of cortisol and norepinephrine levels), increase of the feeling of pleasure and well-being (due to the increase of the synthesis and release of dopamine and serotonin), and influence on memory recall and possible consolidation (Mosini et al., 2019). The technique of controlled breathing in TM results in controlled respiration rate and reduced blood pressure (Murray and Hoshiyama, 2018). Deep breathing in TM has long been proved to be an ultimate tool for curing stress and asthma (Michaels et al., 1976, Wilsonet al., 1975).

Escalation in the research of meditation offer challenges to develop techniques and technology to measure meditation levels. A western research led by an American psychologist, Gardner Murphy specifically focused on investigating Swami Rama's abilities to control different bodily functions that were previously thought completely involuntary, such as his heartbeat and blood pressure (Feuerstein, 2014). The results initiated research on effects of meditation on non-meditators, patients with specific diseases, mental disorder, youth problems in coping with life and many others. Use of refined psychometric methods to research meditation has become the tool for its integration into theoretical and clinical approach (Wielgosz et al., 2019). Religiosity has also been combined with meditation to study the psychological effects, especially on the explanatory power of adjustment (Montero-Marin et al., 2019). Meditation interventions have yielded positive results in fostering great attention to the present as well as providing a better psychological out look towards life (Creswell, 2016). A research

analysis on brain activity during meditational awareness proved that music helps in generating beyond the mind experience with attainment of higher state of internalized meditation (Teixeira et al., 2018). A singing bowl sound meditation provides betterment in mood, reduction in tension and increment in well being (Goldsby et al., 2017).

Meditation hasalso well-established benefits in affective and cognitive processes (Tang et al., 2015). It has been proposed that cognitive and affective effects may differ according to the type of meditation performed (Lutz et al., 2008a,b). Attention training practices include focused attention and open monitoring. A study, documented brain activity during different phases of focused-attention meditation and provided a fine-grained temporal analysis of fluctuating cognitive states (Hasenkampet al., 2012). Both focused attention and open monitoring yoga meditation have been shown to enhance attention control, emotion regulation, self-awareness, and improve cognitive control of conflict (Lippelt et al., 2014; Tang et al., 2015). Open monitoring practitioners tend to have a generally wider attention scope and perform better on sustained attention tasks (Ainsworth et al., 2013; Lippelt et al., 2014).There is an accumulation of evidence based research that provides direct and indirect benefits of yoga meditation. They are said to modulate the brain mechanism that affects behavior and anxiety (Krishnakumar et al., 2015). Sahaja yoga on practitioners meditating daily at home for few minutes or have attended atleast two 45 minutes organized session per week showed positive results. Research reveals that the meditators are less upset, less angry, less nervous, less tired and are in a state of near well being as compared to non-practioners (Hendriks, 2018).

Specific study provided evidence that long-term and deep meditation gives better results as compared to short-term meditation. Though short-term meditation training has become a successful tool to improvise attention, mood, immune function, reduces level of stress hormones, in general provides self-regulation, a study on long-term meditators during open eye mindfulness meditation provides evidence of change in frontal theta activity and white matter plasticity (Tang et al., 2017, 2019). Long-term meditators can shift reliably between rest and meditation state within one minute (Nair et al., 2017). A study shows that acute activation differences observed during meditation relative to rest in long-term practitioners of sahaja yoga meditation reflects on the brain structure, as increased

regional grey matter differences (Hernández et al., 2016). In addition, MBSR led to changes in the amygdala consistent with improved emotion regulation. These findings indicate that long term MBSR-induced emotional and behavioral changes are related to functional and structural changes in the brain (Gotink et al., 2016). During aging process, large scale brain networks exhibit changes in functional connectivity. Recent research suggests that yoga and other contemplative practices may revert, atleast in part, some of the aging effects in brain functional connectivity (Santaellaet al., 2019). Mental quiescence and mindfulness awareness are said to pervade daily life with continued meditation practice and ought to leave an imprint on the activity of distributed brain networks. It has been recently proved that brain electric microstates and felt states of awareness are modulated by long-term meditation (Zanesco et al., 2019).

In recent years, these studies have increasingly involved the use of modern scientific techniques and instruments. With the aim to find the best non-invasive and non-intrusive tool to study meditation many techniques have come into existence. An electro-encephalogram (EEG)is a technique to record the electrical signals of the brain which uses sensors for detecting the changes. These sensors, called electrodes, pick up electrical activity from neurons and send them to a machine which records the brain activity but does not stimulate it. Diagnostic applications focus either on event-related potentials or on the spectral content of EEG. Despite limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis. The first study using an electroencephalogram (EEG) occurred in 1955 which captured the brain activity (Feuerstein, 2014). A great deal of research work with EEG lately has focused on detecting the rest and attention state of mind during meditation. It is reliable and can be used for measuring the results of control tasks (Martisiuset al., 2016). An emotion recognition interface has been developed using complex EEG/ECG bio-signals (Shin et al., 2017). A unique environment of whole body perceptual deprivation (WBPD) used to induce altered states of consciousness that the individual EEG alpha profiles prove to be gender-dependent and indicate subjective experiences. Recent results indicate that the individual alpha profiles are reflected in individual differences in subjective experience. However, the alpha profiles are confounded with the gender of the participant. Specifically, there is a predominant R > L asymmetry found for male

participants, and a predominant L > R asymmetry found for female participants (Glicksohn et al., 2019). An EEG study of Buddhist meditation provides evidences of remarkable nature that reflects a profound disruption of human default consciousness when the personal element is progressively withdrawn, i.e., subjects develop the ability to consciously evoke clonic seizure-like activity at will, under full control (Dennison, 2019).Further investigations on other meditation practitioners studied by EEG proved that meditation decreases mental stress, alcoholic tendencies, drug abuse cases and crime rate in the society (Rao et al., 2015, Bédard et al., 2014, Tang et al., 2015).

After the perception of meditation became more known to the scientists EEG evolved into Magneto-encephalography (MEG). MEG is a functional neuro-imaging technique for mapping brain activity by recording magnetic fields. The process uses sensitive magnetometers for reading electric signals of the brain. Arrays of SQUIDs (superconducting quantum interference devices) are currently the most common magnetometer, while the SERF (spin exchange relaxation-free) magnetometer is being investigated for future machines. This technique is non-invasive compared to other techniques such as MRI, fMRI, EEG. Recordings of EEG and MEG during transcendental meditation report that higher frontal and central alpha EEG activity is associated with MEG source location in the medial frontal. Findings indicate the feasibility and effectiveness of implementing meditation to improve brain integration and positive affect and reduce psychological distress in government administrators and staff (Tarvis et al., 2018). A long lasting change in hippocampal functional topology is induced during resting state mindfulness meditation (Lardone et al., 2018). A MEG study on long-term meditators performing mindfulness meditation with open eye provides evidences of change in spectral power and functional connectivity (Wong et al., 2015).

One of the other technologies used is biofeedback. It is a technique in which people are trained to improve their health by learning to control certain internal bodily processes that normally occur involuntarily, such as heart rate, blood pressure, muscle tension and skin temperature. Meditation mainly focuses on healing oneself with self awareness and biofeedback proved to be a great help in this endeavor. The automated self-correct process helps in reducing coronary risk factors such as blood pressure level, pulse rate, smoking habits as well as serum cholesterol, triglycerides and free

fatty acids in humans by behavior modification evolved through biofeedback-aided relaxation and meditation (Patel and Carruthers, 1977). Frontal muscle EMG biofeedback combined with transcendental meditation produced decreased muscle tension and concomitant changes in locus of control (Zaichkowsky and Kamen, 1978). The need for stress-reducing methods is great in the western society due to a highly stressful lifestyle. Mindfulness meditation based on biofeedback of physical activity and heart rate variability provides stress reduction (van der Zwan et al., 2015). The method and apparatus for providing biofeedback during a meditation exercise includes wearable device with one or more biometric sensors and a user interface. An investigation made on differential effects of yoga for six week duration for curing pain, catastrophizing, and sleep in women suggests greater ease of use of meditation with sufficient practice and a preference towards relaxation monitored through biofeedback simulations with realistic images (Koulouris et al., 2019). Mind-body technique meditation in correlation with biofeedback has also been recently shown to reduce stress and primary headaches in children (Jong et al., 2019).

Infrared thermography (IRT) is a completely non-invasive, non-intrusive, non-radiating, low cost detection tool used for analyzing physiological functions related to skin temperature. Technological advances have made medical thermographic imaging a reliable medical measurement tool. There are potential applications in the field of vascular disorders, endocrinological disorders (especially diabetes mellitus), regenerative medicine, musculoskeletal disorders, neurological disorders, oncology and surgery. It also helps understand mechanisms of action of traditional systems of medicine such as yoga, Ayurveda, acupuncture and meditation (Jasti et al., 2019). The method of highly sensitive thermal imaging has been recently used widely to investigate the rise in temperatures at various areas of the face/body and the autonomic correlates of implicit emotion regulation in patients (Panasiti et al., 2018). A recent study on the effect of mindfulness meditation on the autonomic activity characterized by thermal profile of forehead region documented difference in the meditators and the non-meditators. In meditator group, the mean temperature of forehead region was found to increase during the meditation as a result of increased blood flow in the cerebral cortex of the brain and cutaneous vessels of the face. In the case of non-meditators the forehead temperature either decreased

or fluctuated around the baseline temperature. Hence, the facial IRT can be used as a bio-trainer and biofeedback system which assists both the meditators and novices to sustain and monitor the meditation performance quantitatively (Singh et al., 2018). Digital infrared thermographic imaging (DITI) technology can be used to document, under near-dark conditions, physical phenomena reported by a medium (Boccuzzi, 2017). Digital image processing has been used to deal with different problems in soil related studies. A new method uses digital image processing algorithm to analyse the soil movement during tillage operations (Li et al., 2018). An optimized method of IRT has been used to measure temperature variation of human forehead while and after entering in the meditative state (Jian, 2019). A fourier transform infrared (FTIR) spectra of saliva obtained from the meditation practitioner proved that core body temperature and temperature of some specific facial areas is accompanied by altered metabolic state during brief session of guided Kriya Yoga meditation (Basu, 2015). A study on g-Tummo meditation practitioners resulted in increase in the mean body temperature and a linear variation with alpha power (Kozhevnikov, 2019).

The first cross-sectional study to document that meditation is associated with structural changes in the brain and provides evidences that meditational experience is associated with increased cortical thickness (Lazar et al., 2005). Meditation experience is also associated with differences in default mode network activity and connectivity (Brewer et al., 2011). A latest review carried on this issue provides sufficient evidence to consider it as a fact (Fox et al., 2014). A study conducted on effects of mindfulness using active controls revealed that there is a cognitive affect on neural plasticity during the intervention (Allen et al., 2012). Neural correlates of attention in long-term meditation practitioners were documented in one of the first cross-sectional studies on focused meditation. A longitudinal study documented that short-term mindfulness meditation training induces white matter changes in the anterior cingulated (Tang et al., 2010). The neural mechanisms of symptom improvements in generalized anxiety disorder following randomized mindfulness studies have been recorded in a study based on meditational research (Hölzel et al., 2013). A variety of meditation practices are used for purpose of research in different fields and to get neural correlates by comparing the neural oscillatory patterns of the brain during these forms of meditation (Lee et al., 2018).

Gray matter and functional connectivity in anterior cingulate cortex are associated with the state of silence during sahaja yoga meditation when the meditator enters deep meditation. The results have been confirmed by using an echo planar imaging in fMRI. A fMRI study carried out on the three states; focused attention on object of meditation and meditation with focused attention without effort show effective results, as the practitioners went into deeper meditation (Telles et al., 2014). Though research on effect of mantra meditation on the brain is sparse, positive results have been yielded by the studies in this field. A study on Gayatri mantra meditation demonstrated that mantra recitation changes the brain activity. The results show that the areas which had maximum activation were the bilateral superior temporal gyri, right temporal lobe, right insula, left inferior parietial lobule, lateral globuspallidus and culmen of the cerebellum (Thomas and Rao, 2016). Exploration of differences in whole brain resting state functional connectivity between experienced yoga practitioners, experienced meditators and matched controls proved that there is a functional connectivity of the caudate in older adults who practice kripalu yoga and vipassana meditation.

Multi-modal MRI findings in long-term meditation has provided evidences in structural changes in social affective networks (Engen et al., 2018). A systematical review of the evidence of the effect of secular mindfulness techniques on function and structure of brain based on areas known from traditional meditation using neuroimaging, has given demonstrable functional and structural changes in the prefrontal cortex, cingulate cortex, insula and hippocampus, which are similar to changes described in studies on traditional meditation practice regularly proving the effectiveness of long-term meditation (Gard et al., 2015).

Psychometry can be thought of as a part of yoga meditation as the word itself means ‘measuring the soul’. Studies on meditation incorporate psychometric analysis also since it is a form of self-assessment. Though it is a vulnerability risk factor for a number of psychological disorders, it is still usable in normal circumstances. A study evaluated the efficacy of a loving-kindness meditation programme designed to increase self-compassion in a sample of self-critical individuals. Thirty-eight individuals with high scores on the self-critical perfectionism subscale of the dysfunctional attitude scale were randomized to love-kindness condition ($n = 19$) and a wait-list (WL) condition ($n = 19$).

Measures of self-criticism, self-compassion and psychological distress were administered before and immediately following the intervention. Results showed significant reductions in self-criticism and depressive symptoms as well as significant increases in self-compassion and positive emotions in the LKM condition compared with the WL condition. A follow-up per-protocol analysis in both groups together showed that these gains were maintained 3 months after the intervention also. These preliminary results suggest that LKM may be efficacious in alleviating self-criticism, increasing self-compassion and improving depressive symptoms among self-critical individuals (Shahar et al., 2014). Another study on 199 practitioners for development and psychometric properties of the self-efficacy measures performed for mindfulness meditation practice scale was uni-dimensional with three sub-constructs of attention, compassion, and emotion. This study provides preliminary evidence that self-efficacy for mindfulness meditation practice scale is a reliable and valid measure (Birdee et al., 2018).

Recently, pioneering theoretical and experimental scientific studies on Surat-Shabda yoga have also been carried out. Theoretical studies include the Systems Modelling of Macrocosm and Microcosm in the Domain of Spiritual Consciousness, Applied Systems Research for Better Worldliness, Spiritual System Theory Framework for the entire spectrum of consciousness, Modeling in Cosmology,Cosmology from the twin vantage points of Radhasoami Faith and Systems Science, Eastern Philosophy in the Spiritual Traditions of Oriental Saints ("Sants"): An Interpretive Structural Model (ISM) Representation, Study of Human Consciousness as a Surrogate of Macrocosmic Consciousness via Scientific Measurements of Electromagnetic Wave Radiations, the Omni-Quantum Theory for Spiritual Consciousness System, Neuro-Environmental Cognitive Spiritual Phenomenology, Hierarchical Order Theory (HOT) of Consciousness, Approach to Integrate Arts (First-Person Spiritual-Cognitive--Material Phenomenology) and Science (Third-Person Neuro-Physical Environmental-Cognitive Correlates) of Consciousness, Integration of East-West Approaches to Consciousness, Spiritual-Psycho-Physical Quantum Theory of Consciousness, with systems based on concrete reality through semi-abstract cognitive systems to highly abstract quantum

field theory-based systems (Satsangi et al., 2008a, 2009, 2010, 2007, 2008b, Srivastava et al., 2011, Satsangi et al., 2012a,b, 2013a,b,).

A general rudimentary graph theoretical modeling framework for spiritual domains has been proposed that involves eighteen different levels of consciousness spanning the physical region, region of the universal mind and the pure spiritual region. An omni-quantum theory for spiritual consciousness has been proposed that explains the quantum nature of consciousness (Satsangi, 2010). Further, Graph Theoretic Quantum System Modeling (GSTQM) has been applied for Quantum Information Processing Circuits that include, Logic Circuits : CNOT, Hadamard, etc., Quantum teleportation circuit as a complex "System of Systems" and 3-particle to n-particle quantum teleportation, has also been used to model microtubules in the brain as multi-level quantum Hopfield networks and n-Qubit multiparticle teleportation to n-Qudit contextuality-based quantum teleportation and beyond, to explain different aspects related to consciousness(Srivastava et al., 2011, 2014, 2016, 2017).

Experimental studies include, the Measurement of Environmental Correlates of Consciousness during Ultra-Transcendental Meditation at higher apertures in the brain with MEG, Superconducting Quantum Interference Device (SQUID), to measure very weak magnetic fields in a magnetically shielded room. Different states of consciousness during Surat-Shabda Yoga meditation have been characterized in terms of frequencies recorded with MEG. The famous Weber–Fechner Power Law in Psycho-physics has also been generalized and extended to the spiritual (pure consciousness) domain (Satsangi, 2015). This characterization of the main states of consciousness in terms of frequencies, facilitates the determination of consciousness of any individual with the non-invasive MEG technique. Psychometric Studies on the effect of Surat-Shabda Yoga meditation have also been reported using various tests that include, Myers-Brigg Type Indicator (MBTI) Test, Daily Religious Inventory (DRI), Consciousness Quotient (CQ), Spiritual Quotient (SQ), Vedic Personality Inventory (VPI), Strength Deployment Inventory (SDI) and a Musical Consciousness Test(Bhasin et al., 2016, Pyari et al., 2015, 2019).

4. Challenges

Once considered beyond the reach of science, the neural mechanisms of human consciousness are now being unravelled at a startling pace by researchers. However, the basic challenge in consciousness studies is how to explain the relationship between physical phenomena, such as brain processes, and experience (i.e., phenomenal consciousness, or mental states/events with phenomenal qualities or qualia). This is referred to as the hard problem of consciousness (Chalmers 1995). In other words, why are physical processes ever accompanied by experience? Perception of color is still an open question, i.e., why a given physical process generates the specific experience it does. In contrast to the hard problem, explanation of how the brain integrates information categorizes and discriminates environmental stimuli, or focuses attention are easy problems. Such phenomena can be functionally defined. It is argued that the hard problem may remain unsolved even if neural correlates of consciousness are discovered.

Meditation is an age old well-established experiential science that is actively practiced widely in the East. Although it has been scientifically studied over the past six decades, there are many challenges that need to be overcome, which include, access to advanced meditators willing to subject themselves to scientific study, identification of an accurate, non-invasive, non-intrusive and sensitive technique to measure subtle effects, large sample sizes and proper controls. As per the discipline, meditators are not permitted to publicly report inner experiences, except to their teacher or adept, unless specially ordained.

Meditation has acquired greater importance in neurophenomenology, in which subjects are required to hold attention on an object or thought long enough to make reliable neuroimaging measurements. There is growing acceptance of the importance of the integration of first-person phenomenology with third-person objective measurements (Priceand Barrell, 2012, Walach, 2011, 2014).However, effective expressions in reporting inner experiences, especially the transcendental and ultra-transcendental experiences that are known to be ineffable require meditators with considerable expertise to accurately report their experiences.

5. Motivation

Surat-Shabd Yoga meditation is a very powerful, engaging and less studied technique. Some pilot scientific studies have been carried out recently that have shown excellent results. More detailed studies are required on its effect on various psycho-physiological states that include larger samples, better controls and multiple techniques. DEI provides access to a neighborhood community that has been advocating and practicing Surat-Shabd Yoga meditation (ultra-transcendental) over the last 200 years. The availability of meditators practicing under an experienced adept and the availability of adequate resource provided the motivation to undertake this research.

6. Objectives

The broad objective of the proposed thesis is to study the effect of Surat-Shabda-Yoga meditation on psycho-physiological states of consciousness. As mentioned earlier, some pioneering studies have been carried out using MEG and psychometric tests. Pioneering experiments with MEG have determined neuro-environmental correlates of higher states of consciousness (transcendental and ultra-transcendental) during meditation in terms of frequencies, by integrating first-person and third-person perspective in contemplative neuroscience. Frequencies of 3 Hz, 4.5 Hz, 76 Hz, 108 Hz and 126 Hz have been determined to correspond to the five main higher consciousness states. Stimulus (MEG) and sensation using analytical hierarchical process (AHP) have been integrated to yield a power law of meditational consciousness, which is a generalization of Weber–Fechner law in psychophysics (Satsangi et al., 2016). These different states would certainly have an effect on the health and wellbeing of meditators. Hence, it is proposed to study the effect on the psychological and physiological states of meditators through MEG, corresponding to the range of frequencies measured.

A preliminary researches been reported using EEG, ECG, SBP, DBP and heart rate that exhibits considerable increase in theta wave activity and high increase in delta wave activity. The significant decrease in beta wave activity indicated lesser anxiety and mental stress (Singh and Saxena, 2013). Further study to find the change in factors such as well-being level, stress level, mental peace, blood pressure, breathing regulation, intuitive level, anger, agitation, daily life activities both based on

mental and physical efficiencies, concentration and others needs to be conducted to record the benefits of Surat-Shabd Yoga meditation. To the best of our knowledge no rigorous study has been conducted to date. Hence, it is proposed to carry out a detailed study on the psycho-physiological and behavioral changes induced by Surat-Shabd Yoga meditation using EEG.

It is proposed to carry out a parallel study using biofeedback to analyse the change in various factors involved in biofeedback before and after the Surat-Shabd Yoga meditation.

A recent study on thermographic evaluation of mindfulness meditation using dynamic IR imaging has revealed that the average forehead temperature increases during meditation. It is well known that breathing has a very intricate connection with mind. According to the ancient Swara Yoga Shastra, focus and control of breathing is a prerequisite for quietening the mind. This is achieved through Pranayama technique. In meditation, at the equilibrium state, the respiration becomes light and balanced. This can be effectively monitored by measuring the temperature and breathing rate using infra-red thermography (IRT) which is a non-invasive and non-intrusive technique.

A pilot study with IRT has provided evidence of decrease in the temperature at the two nostrils and becoming constant during Surat-Shabd Yoga meditation (Saran and Roy, 2019). It is proposed to undertake a detailed study using this technique by monitoring different regions of interest related to meditation.

It is important to study the effect of the duration of Surat-Shabd Yoga meditation. Duration of a single session and regular practice over a considerable period of time would enable better insights into the effect on various psycho-physiological parameters. Hence, it is proposed to carry out a detailed study on long-term and short-term meditators.

Different techniques have been used to study the effect of different types of meditation in different environments. It is important to study the correlation between different experimental techniques and different psycho-physiological parameters for a particular type of meditation, corresponding to the same consciousness state. As in the case of health diagnosis, multiple tests provide better insights into the state of an individual, multi-modal analysis of meditation is also required to characterize different

consciousness states. It is proposed to study the effect of Surat-Shabd Yoga meditation through different techniques and correlate the results obtained. For instance, the frequencies measured through MEG will be correlated, alpha power measured with EEG and with the respiration rate using IRT, for a meditator during Surat-Shabd Yoga meditation.

Subjective experience can only be characterized through psychometric tests. Some preliminary studies on the effect of Surat-Shabd Yoga meditation have been reported based on the Myers-Briggs Personality Type Indicator (MBTI); Consciousness Quotient Inventory (CQI) Test; Freiburg Mindfulness Inventory (FMI) Test, and Extraordinary Experiences Quotient Test (EEQ) (Satsangi 2012a, Stein and Swan 2019, Brazdau 2015, Walach, 2016). It is proposed to conduct a detailed study of the personality and psychological states, especially intuition of the Surat-Shabd Yoga meditators. These psychometric tests will also be correlated with other techniques mentioned above.

Various theories have also been proposed to explain the nature of consciousness, its spectrum and the process of Surat-Shabd Yoga meditation to attain them, based on systems theory, quantum physics and quantum information processing (Satsangi, 2012a, 2019). It is proposed to develop a quantum psycho-physical theory of consciousness considering embodied consciousness to be an open quantum system that interacts with the environment at physical and mental (subtle) levels. An effort will also be made to apply the principles of quantum cognition to explain the working of the mind and beyond.

The specific objectives for the proposed research work have been outlined as follows:

1. It is proposed to experimentally study the effect of advanced Surat-Shabd Yoga (ultra-transcendental) meditation on the physiological, psychological, intuitive and behavioral changes through different techniques that include the following:
    a. Magneto-encephalography (MEG)
    b. Electro-encephalography (EEG)
    c. Biofeedback
    d. Infrared thermography (IRT)
    e. Psychometry

2. It is proposed to characterize different psycho-physiological states of consciousness through meditation.
3. An attempt will be made to compare and correlate different experimental techniques to study meditation.
4. A study on the effect of meditation on short-term and long-term meditators is proposed.
5. A theoretical understanding of states of consciousness induced through meditation, based on psycho-physics and meta-physics is proposed.

7. Methodology

The proposed study will be carried out by first selecting short-term and long-term Surat-Shabda-Yoga meditators. This would be achieved by administering suitable psychometric tests. Short-term meditators would be considered having an experience of meditation ranging from one to five years, whereas, long-term meditators having ten years or more. Both male and female meditators will be considered. A psycho-physiological assessment will be carried out to ascertain the initial state of the subjects through multiple psychometric tests. This would enable correlation of various psychological parameters. A detailed health assessment will also be carried out to determine the physiological state of the subjects. Results will be analysed to determine the relationship between health and well-being. A control group of non-meditators will be identified having the same age group. It is also proposed to consider subjects having specific psychological and physiological ailments, to study the effect of Surat-Shabda-Yoga Meditation.

The effect of Surat-Shabda Yoga meditation on psycho-physiological states has been described in scriptures and the teachings of Sant Mat. A working hypothesis based on these experiential descriptions will be formulated and tested with different experimental techniques.

A detailed study based on biofeedback technique will be carried out that includes the measurement of pulse rate, heartbeat, galvanic skin conductance, body temperature and brain activity. The response of subjects to visual and acoustic stimulation will be recorded. Results will be analysed and correlated with psychometric tests.

The effect of the duration of Surat-Shabda-Yoga meditation will be studied in detail. A study on non-meditators or beginners will be carried out, considering a single session of 30 minutes and after regular meditation practice of three months and six months. The effect of meditation on intuition will be also studied.

In a recent experiment on mindfulness and g-tummo meditation, infrared thermal imaging has been used to determine the change in the body temperature. It has been found that the average forehead temperature and the average body temperature increases respectively. In the proposed study different regions of interest, such as region between the eyes, nostrils, palm and tips of fingers will be monitored using infrared thermography (IRT). A detailed study on the effect of Surat-Shabda-Yoga meditation on respiration will be carried out. An effort will be made to determine the change in the respiration rate when the meditator experiences different states of consciousness, during meditation. The results will also be correlated with those obtained on other parameters using different techniques.

It is important to carry out a detailed study on the effect of Surat-Shabda-Yoga meditation using multiple techniques. Since the techniques used should preferably be non-invasive, IRT can be combined with Biofeedback, EEG and MEG techniques, as thermal imaging can be carried out remotely without disturbing the EEG and MEG setup, which is not applicable for EEG and MEG measurements. EEG signatures of different group of meditators will be determined and changes monitored during Surat-Shabda-Yoga meditation.

MEG measurements will be carried out at the facility in the electro-magnetically shielded room available at the Institute's Centre for Consciousness Studies. The MEG characterization of the states of consciousness of different subjects will be undertaken and results analysed based on the recently proposed power-law of meditational consciousness.

The results obtained on the effect of Surat-Shabda-Yoga meditation through various techniques will be compared and analysed to identify specific markers of different psycho-physiological states and a theoretical understanding will be developed based on the principles of psycho-physics and quantum cognition. The study will provide scientific evidence and explanation of the ancient experiential science of meditation, practiced and described in Indian scriptures.

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